Electronic Version
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Claims

[c1] 1.A heat sink for attachment to a memory module comprising:
a front plate for attaching to a front surface of the memory module and a back plate for attaching to a back surface of the memory module, each plate comprising:
a heat-transfer area for making thermal contact with memory chips mounted on the memory module;
a bottom edge portion that provides a bottom opening between the plate and the memory module for an entire length of a bottom edge when the plate is attached to the memory module, the bottom edge of the memory module containing metal contacts for making electrical contact to a memory module socket;
a top attachment portion for making contact with a substrate of the memory module near a top edge that is opposite the bottom edge of the memory module;
fastener holes for fasteners in the top attachment portion, the fasteners for fixedly attaching the plates to the substrate of the memory module;
a pair of side portions that each make contact with the substrate of the memory module in an upper side portion near the top edge, but do not make contact with the

substrate for a lower side portion near the bottom edge; and

top-edge slots formed near the top edge in the top attachment portion of the plate, the top-edge slots for allowing air flow underneath the plate between the plate and the substrate, from the bottom opening to the top-edge slots,

whereby air-flow underneath the plate is provided by the top-edge slots.

[c2] 2.The heat sink for attachment to a memory module of claim 1 wherein the upper side portion extends from the top edge to an upper side notch in the substrate;

wherein the lower side portion extends from near the bottom edge to the upper side notch in the substrate,

whereby the upper side portion above the upper side notch is closed by the plate contacting the substrate, but the lower side portion below the upper side notch is open, with a gap between the plate and the substrate.

[c3] 3.The heat sink for attachment to a memory module of claim 2 wherein the top attachment portion contacts the substrate for an entire length of the top edge of the substrate,

whereby the top attachment portion contacts the substrate above the top-edge slots.

[c4] 4.The heat sink for attachment to a memory module of claim 2 wherein the top attachment portion contacts the substrate for contact portions of the entire length of the top edge of the substrate,
wherein the contact portions surround the fastener holes in the top attachment portion;
wherein the top-edge slots extend to the top edge, dividing the contact portions of the top attachment portion.

[c5] 5.The heat sink for attachment to a memory module of claim 2 wherein the fastener holes comprise:
a top-left fastener hole near a top-left corner between the top attachment portion and a left side portion of the pair of side portions;
a top-right fastener hole near a top-right corner between the top attachment portion and a right side portion of the pair of side portions;
a top-center fastener hole in the top attachment portion between the top-edge slots.

[c6] 6.The heat sink for attachment to a memory module of claim 5 wherein the fastener holes further comprise:
a bottom fastener hole in the bottom edge portion.

[c7] 7.The heat sink for attachment to a memory module of claim 6 wherein the bottom fastener hole is about half-

way between the pair of side portions.

[c8] 8.The heat sink for attachment to a memory module of claim 7 wherein the heat-transfer area is a depression in the plate surrounded by a raised ridge in the plate.

[c9] 9.The heat sink for attachment to a memory module of claim 8 wherein the top-edge slots are formed on a sloping portion of the plate between the raised ridge and the top attachment portion.

[c10] 10.The heat sink for attachment to a memory module of claim 9 wherein the top-edge slots comprise two slots in the front plate and two slots in the back plate,
whereby four top-edge slots provide for air-flow underneath the plates.

[c11] 11.The heat sink for attachment to a memory module of claim 10 wherein the fasteners are rivets, nuts and bolts, or screws and nuts.

[c12] 12.A thermally-enhanced memory module comprising:
a substrate having wiring traces formed therein;
metal contacts along a contactor edge of the substrate, the metal contacts for making electrical contact with a memory module socket;
a first plurality of memory chips mounted on a first surface of the substrate;

a first heat-transfer plate having an underside surface making thermal contact with the first plurality of memory chips and an exposed surface opposite the underside surface, the exposed surface for dissipating heat;

a contact-side opening between the first heat-transfer plate and the substrate near the contactor edge of the substrate, the contact-side opening allowing air flow to the first plurality of memory chips;

an attachment portion of the first heat-transfer plate that contacts the substrate along an opposite edge that is opposite the contactor edge;

a plurality of fasteners in the attachment portion that fixedly attach the first heat-transfer plate to the substrate; and

a plurality of slots through the first heat-transfer plate between the attachment portion and a chip-contact portion of the first heat-transfer plate that makes contact with the first plurality of memory chips;

wherein the substrate further comprises fastener holes in the substrate for receiving the plurality of fasteners to fixedly attach the first heat-transfer plate to the substrate,

whereby heat-transfer is enhanced by air flow through the plurality of slots, past the plurality of memory chips, and through the contact-side opening.

[c13] 13.The thermally-enhanced memory module of claim 12 further comprising:

a second plurality of memory chips mounted on a second surface of the substrate that is opposite the first surface;

a second heat-transfer plate having an underside surface making thermal contact with the second plurality of memory chips and an exposed surface opposite the underside surface, the exposed surface for dissipating heat;

a second contact-side opening between the second heat-transfer plate and the substrate near the contactor edge of the substrate, the second contact-side opening allowing air flow to the second plurality of memory chips;

an attachment portion of the second heat-transfer plate that contacts the substrate along an opposite edge that is opposite the contactor edge; and

wherein the plurality of fasteners in the attachment portion fixedly attach the second heat-transfer plate to the substrate and to the first heat-transfer plate;

a second plurality of slots through the second heat-transfer plate between the attachment portion and a chip-contact portion of the second heat-transfer plate that makes contact with the second plurality of memory chips.

[c14] 14.The thermally-enhanced memory module of claim 13 wherein the attachment portion comprises an entire length of the opposite edge of the substrate.

[c15] 15.The thermally-enhanced memory module of claim 13 wherein the attachment portion comprises contact portions of the opposite edge of the substrate;
wherein the contact portions comprises less than an entire length of the opposite edge.

[c16] 16.The thermally-enhanced memory module of claim 14 wherein the attachment portion further comprises upper side portions along upper portions of sides of the substrate.

[c17] 17.The thermally-enhanced memory module of claim 16 wherein the upper side portions are portions with no side notches.

[c18] 18.The thermally-enhanced memory module of claim 17 wherein the substrate is a printed-circuit board (PCB) and wherein the plurality of fasteners are rivets, screws and nuts, or nuts and bolts.

[c19] 19.A memory module comprising:
memory means for storing data;
substrate means for supporting the memory means;
fastener holes in the substrate means;

contactor means, along a contactor edge of the substrate means, for making electrical contact when the memory module is inserted into a socket;

wiring means, within the substrate means, for electrically connecting the memory means to the contactor means;

heat-sink means, made of heat-conducting material, for dissipating heat from the memory means;

depression means, in the heat-sink means, for thermally contacting the memory means;

top attachment portion means, in the heat-sink means and along an opposite edge of the substrate means, for physically contacting the substrate means along the opposite edge;

fastener means, attached to the top attachment portion means, for fixedly attaching the heat-sink means to the substrate means through the fastener holes in the substrate means; and

opposite-edge slot means, formed between the top attachment portion means and the depression means, for allowing air flow through the heat-sink means between the memory means and the opposite edge,

whereby air-flow under the heat-sink means is improved by the opposite-edge slot means.

[c20] 20.The memory module of claim 19 wherein the heat-sink means comprises a first sink means for attaching to

a first surface of the substrate means and a second sink means for attaching to a second surface of the substrate means.